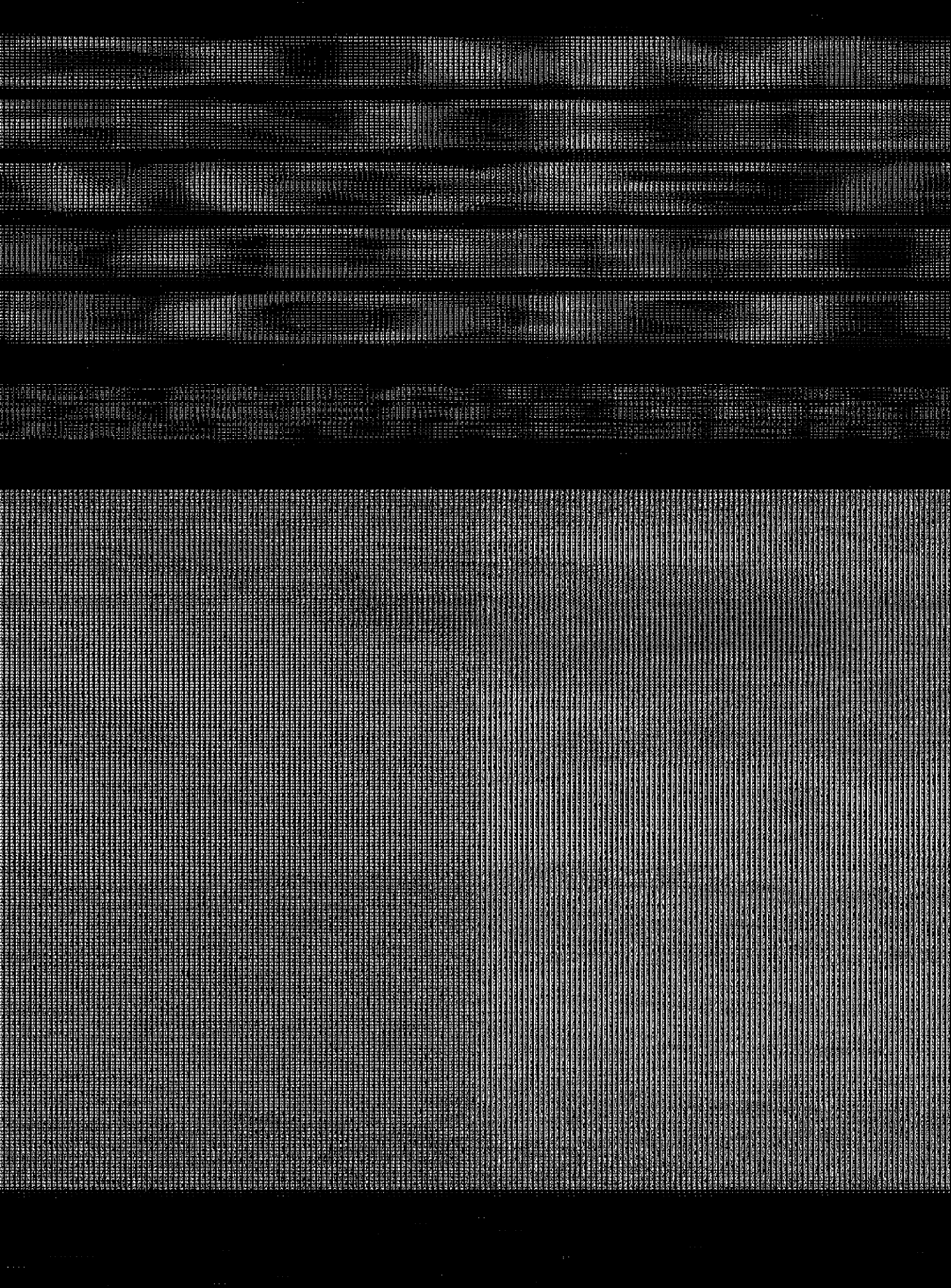

ECONOMIC IMPACTS OF CONTROLLING SURFACE WATER RUNOFF FROM FED-BEEF PRODUCTION FACILITIES by J.B. Johnson, Gary A. Davis, J. Rod Martin, and C. Kerry Gee. Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 292.

ABSTRACT

Fed-beef producers in the United States face substantial investments and increased operating costs in complying with effluent limitations guidelines established by the Environmental Protection Agency. This study was designed to provide indications of the extent of fed-beef operation runoff problems and capital investments and annual costs to producers attributable to compliance. It was initiated prior to the passage of the Federal Water Pollution Control Act Amendments of 1972, which established the guidelines.

Findings indicate that total capital investment for facilities and equipment needed to control runoff problems in the 18 leading fed-beef producing States would range from $132 to $136 million. Annual added production costs would total $20 million.

About half of the marketings in these 18 States came from operations with less than 1,000 head capacity in 1972. Costs would fall heaviest on these small operators. In the Eastern States, the average investment per head of capacity for runoff control would average $21 for 100-199 head capacity feedlots and $3 for lots with capacities of 1,000 head or more. In the Western States, investment would average $22 for operations of less than 1,000 head capacity. For larger operations it would average from $1 to $4 per head. Costs per head drop sharply for larger operations in both the Eastern and Western States. Some small-capacity operations in the East may not be able to continue production if they are required to comply with EPA guidelines.

Keywords: Environment, economic impacts, runoff control, effluent guidelines, beef feeding, capital costs, operating costs

Washington, D.C. 20250 July 1975

PREFACE

Economic impacts of implementing point source runoff controls on fed-beef operations are analyzed. Estimates of economic impacts are presented for fed-beef operations of all capacity levels to provide a preliminary assessment for the entire industry. However, final effluent limitations guidelines announced by the Environmental Protection Agency in February 1974, apply only to feedlots with a one-time capacity of 1,000 head or more. The Federal Water Pollution Control Act Amendments of 1972 require EPA to establish effluent limitations guidelines for point source dischargers. Section 301 (b) of the Act requires the application of the best practicable control technology currently available by July 1, 1977; by July 1, 1983, the Act requires the application of the best available technology economically achievable. Final effluent limitations guidelines, considered to be performance standards reflecting the use of both technology planes,were announced by EPA for the feedlots point source category on February 14, 1974.

The Economic Research Service initiated analyses of the economic impacts of imposing surface water controls on the fed-beef, dairy, and swine industries prior to the passage of the Federal Water Pollution Control Act Amendments of 1972. These analyses were designed to provide indications of the extent of surface water control problems; estimate investments and additional costs incurred in the control of surface waters from production facilities; and provide initial indications of the aggregate supply and price effects attributable to implementation of these guidelines.

EPA had not established its guidelines before this study began. Therefore, the major sources for this study were: (1) a background report submitted to EPA as a partial basis for the establishment of guidelines, and (2) a review of the runoff control technologies and practices being used in the individual States. Although the base information from these sources does not coincide exactly with final effluent guidelines announced by EPA, it is sufficiently close to allow meaningful judgments of economic impacts.

The authors appreciate the efforts of those in the 18 major fed-beef producing States who provided estimates of the production technologies in current use and the number of fed-beef operations with existing or potential surface water control problems.

Information of design criteria and investments for runoff control systems in use was provided by staff members of State offices of the Soil Conservation Service, USDA.

Special appreciation goes to Richard J. Patronsky, SCS Water Management Engineer, Midwest Regional Technical Service Center, who was instrumental in planning the acquisition of data from the SCS State offices.

CONTENTS

SUMMARY

U.S. fed-beef producers face rising investments and operating costs as they comply with new pollution control guidelines issued by the Environmental Protection Agency (EPA).

This report evaluates the economic impacts of EPA point source effluent limitations guidelines on the U.S. fed-beef industry. Primary emphasis is placed on the firm-level capital outlays and production cost increases incurred for the control of runoff from fed-beef production facilities. Aggregate industry investment levels and annual fed-beef production cost increases are presented for different feedlot capacity classes and for the fed-beef industry in 18 major producing States.

To date, EPA guidelines affect only those operations of more than 1,000 head capacity. In the 18 States, 181,000 operations (99 percent of the fed-beef operations) have capacities of less than 1,000 head. They produce 51 percent of the fed-beef marketings in these States. The 1,810 fed-beef operations with capacities of 1,000 head or more account for the remaining 49 percent of the total beef marketings. If guidelines are extended to include smaller operations, these operations, especially those in the humid Eastern States, would be hit hardest.

Almost 49,000 fed-beef operations in 18 major producing States had pollution runoff problems at the time of this study. They accounted for 27 percent of all operations and 25 percent of the fed-beef cattle marketings in the 18 States considered. Three-fourths of the operations with problems had capacities of less than 100 head. Only about one-third of the 1,810 fed-beef operations with capacities of 1,000 head or more had problems; of these larger capacity feedlots with problems, only 139 were in the Western States. Fed-beef operations considered to have problems were those with continuous waste discharges or runoff from storm events which would require remedial actions to assure compliance with EPA guidelines.

Industry compliance with EPA guidelines would require capital outlays ranging from $132 million to $136 million. Increases attributable to runoff control in the total costs of producing fed beef would total $20 million annually if all operations with runoff problems took needed remedial actions for runoff control and maintained their historical levels of production. The aggregate industry capital outlay for runoff control and the industry's increase in the cost of fed-beef production are nominal when compared with existing industry investments in beef production facilities and an industry average of $10 billion in value added annually. However, installation of runoff control systems will reduce the economic viability of some fed-beef operations.

Highest per head capital outlays were for small fed-beef operations in the Eastern States. Lowest per head investments occurred on large fed-beef operations in the arid Western States.

The use of runoff control systems would require per head capital outlays of $145 on the average for operations with less than 100 head in the Eastern States. Within this and other capacity classes of fed-beef operations in the Eastern States there is considerable variation in per head capital outlays because of differences in housing type in use. Within a particular capacity class, the land-extensive, open-lot systems will generally incur the largest per head capital outlays followed by the dry-lot unpaved systems and the land-intensive, dry-lot paved systems.

As lot capacity increases, investments per head for runoff control systems decrease. In the Eastern States, the average investment required is $21 for 100-199 head capacity lots and $3 per head for those with capacity of 1,000 head or more. In the Western States, investments for operations with less than 1,000 head capacity average $22 per head. Per head investments within this capacity class vary considerably by State, however. Larger capacity operations in the Western States could incur per head capital outlays ranging from $1 to $4.

Many small-capacity Eastern fed-beef producers might not be able to continue production if EPA effluent limitations guidelines for feedlots with one-time capacities of 1,000 head or more were applied to fed-beef operations of lesser capacity. Cost per head for runoff control drops rapidly for fed-beef operations of larger capacity in the Eastern and Western States.

If those fed-beef operations with a one-time capacity of 1,000 head or more with runoff problems install and use control systems, 36 percent of the runoff previously discharged by the industry would be controlled. The advisability of extending the EPA guidelines for the control of runoff from fed-beef operations of lesser capacity will involve a balancing of the costs and benefits of such an action. The gallons of runoff controlled by operable control systems might be viewed as an upper limit indicator of damages previously inflicted on society (societal benefits when controlled). However, much additional information would be needed to set a monetary value on the benefits of runoff control to society.

ECONOMIC IMPACTS OF CONTROLLING SURFACE WATER RUNOFF FROM FED-BEEF PRODUCTION FACILITIES

by
J. B. Johnson, Gary A. Davis, J. Rod Martin, and C. Kerry Gee 1/

THE PROBLEM

Fed-beef producers face rising production costs as they bring their operations into compliance with effluent limitations guidelines. Substantial capital outlays will be needed to control runoff from fed-beef production facilities. Many States have statutes or codes guiding management of livestock wastes to mitigate water pollution. The Federal Government, through the use of statutory authority, has specified rules that require certain segments of the fed-beef industry to comply with water quality standards.

Under authority granted in the Federal Water Pollution Control Act Amendments of 1972, the U. S. Environmental Protection Agency (EPA) has established effluent limitations guidelines for the control of surface water pollution from point source dischargers, including feedlots. The term "point source" refers to a single, identifiable source of pollution.

This study analyzes the economic impacts of effluent limitations guidelines on the fed-beef industry. The guidelines for the feedlots point source category could change the investment and production cost situation of individual producers, influence the structure of the fed-beef industry, and alter the location of fed-beef production. There are definite trade-offs between desired qualities of surface waters and the economic viability of some fed-beef producers and stability of the fed-beef industry. Knowledge of these trade-offs will provide policy makers with a more complete basis for judging the adequacy of these guidelines.

Geographic Scope of Analysis--This study covers 18 of the major fed-beef producing States which accounted for about 98 percent of all U.S. beef feedlots and 95 percent of the fed cattle marketed in 1969 (tables 1 and 2). States in the Corn Belt, Northern Plains, Lake States, and the Northeast are referred to as the Eastern States in this study. States in the Southern Plains, and Colorado, California, and Arizona are termed the Western States (figure 1).

1/ Agricultural economists, Economic Research Service, U.S. Department of Agriculture.

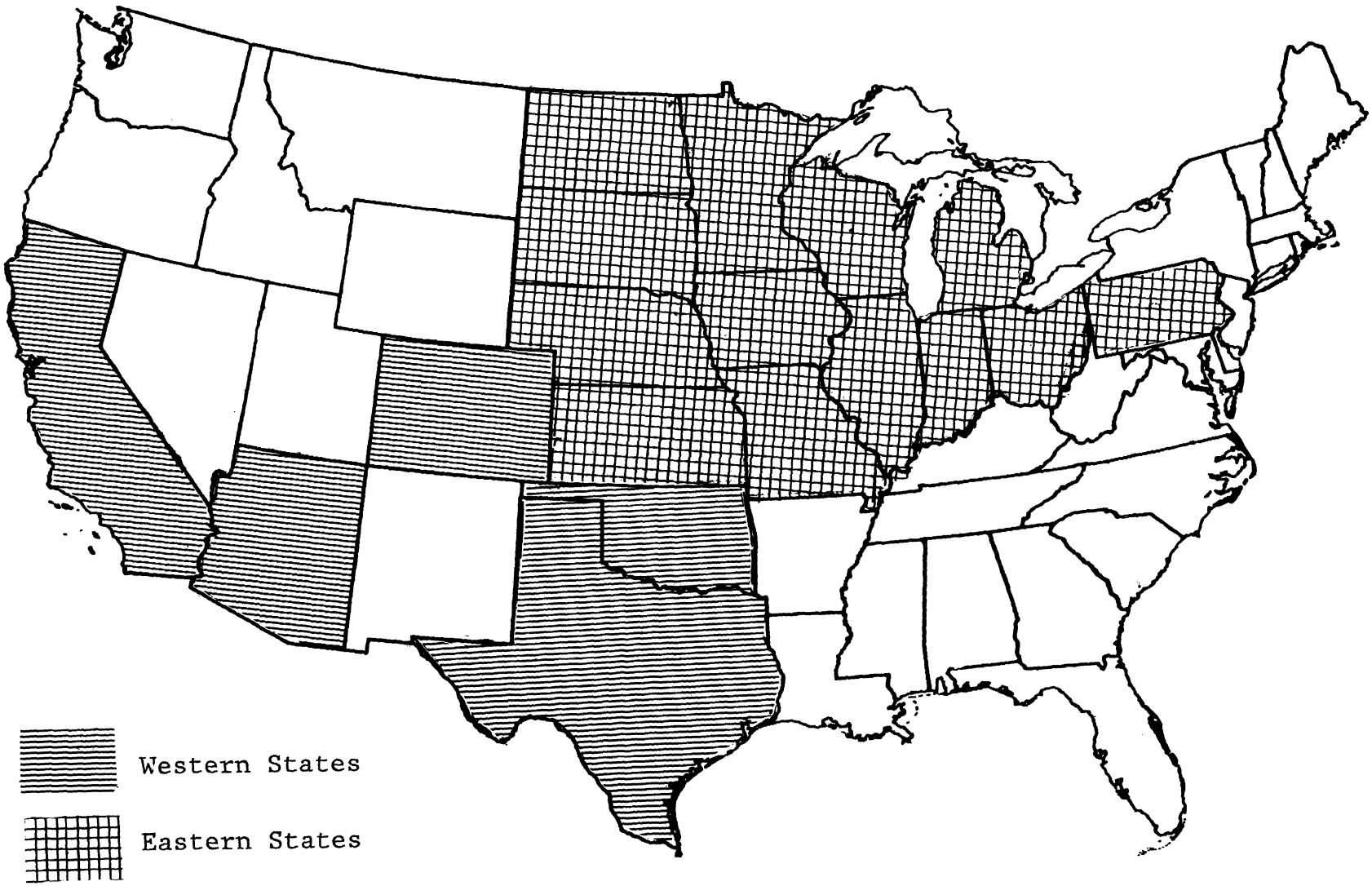

Figure 1--Major beef feeding States, by State groupings.

Table 1--Number of fed-beef operations, by capacity class, 18 major States, 1969

State	Capacity class (head) 1/					
	<100	100-199	200-499	500-999	1,000 and over	Total 2/
	Number					
Pennsylvania	5,526	308	142	20	2	5,998
Ohio	8,838	707	347	79	25	9,996
Indiana	13,263	755	370	86	22	14,496
Illinois	15,038	2,174	1,430	330	32	3/ 19,004
Iowa	33,365	5,805	3,808	859	160	43,997
Missouri	15,615	828	442	81	31	16,997
Michigan	1,125	291	209	52	19	1,696
Minnesota	17,679	1,291	745	152	29	19,896
Wisconsin	7,326	283	145	40	4	7,798
North Dakota	831	150	69	10	19	1,079
South Dakota	7,837	891	485	131	53	9,397
Nebraska	14,574	2,199	1,646	395	486	19,300
Kansas	7,137	869	635	221	124	8,986
Total	148,154	16,551	10,473	2,456	1,006	178,640

State	Capacity class (head) 4/				
	<1,000	1,000-7,999	8,000-15,999	16,000 and over	Total
	Number				
Oklahoma	900	40	4	5	949
Texas	1,300	228	32	40	1,600
Colorado	1,092	90	17	13	1,212
California	173	208	45	28	454
Arizona	8	31	12	11	62
Total	3,473	597	110	97	4,277

1/ Estimates of the distribution of feedlots by feedlot capacity class were made for the 1969 production year from the census of agriculture and [12]. For all capacity classes of less than 1,000 head, estimates were based on annual marketings. Since the turnover rates in smaller capacity feedlots approach 1, annual marketings provide an adequate indication of capacity.

2/ The estimation procedure used distributes SRS (Statistical Reporting Service) estimates of beef feedlots by capacity classes derived from the census of agriculture. Rounding errors in the estimation procedure account for the small differences that are evident when the estimated State totals are compared with corresponding SRS reported feedlots for these States.

3/ Illinois data are adjusted to reflect the deletion of certain small capacity operations to be consistent with currently used definitions.

4/ Values represent the combination of selected capacity classes from [12].

Table 2--Number of fed-beef marketings, by capacity class, 18 major States, 1969

State	Capacity class (head) 1/					
	<100	100-199	200-499	500-999	1,000 and over	Total 2/
	Head					
Pennsylvania	22,011	41,992	42,446	15,868	8,681	130,998
Ohio	134,280	95,591	106,191	65,783	32,152	433,997
Indiana	197,018	102,586	108,945	65,452	43,996	517,997
Illinois	91,978	300,493	423,587	279,339	83,996	3/1,179,393
Iowa	1,569,000	793,263	1,117,591	640,955	423,998	4,544,807
Missouri	345,013	111,913	131,718	62,536	69,816	720,996
Michigan	78,113	40,572	63,237	36,979	25,097	243,998
Minnesota	247,483	174,932	224,759	109,830	45,992	802,996
Wisconsin	89,949	38,221	42,222	31,632	9,973	211,997
North Dakota	4,834	19,984	19,905	9,020	41,652	95,395
South Dakota	47,609	120,843	140,959	153,105	88,482	550,998
Nebraska	713,923	299,723	493,865	69,489	1,776,996	3,353,996
Kansas	192,683	146,796	194,626	173,375	1,145,511	1,852,991
Total	3,733,894	2,286,909	3,110,051	1,713,363	3,796,342	14,640,559

State	Capacity class (head) 4/				
	<1,000	1,000-7,999	8,000-15,999	16,000 and over	Total
	Head				
Oklahoma	64,000	146,000	82,000	207,000	499,000
Texas 1/	111,000	514,000	514,000	1,567,000	2,706,000
Colorado 2/	305,000	412,000	250,000	784,000	1,751,000
California 2/	17,000	350,000	570,000	1,120,000	2,057,000
Arizona	3,000	126,000	165,000	541,000	835,000
Total	500,000	1,548,000	1,581,000	4,219,000	7,848,000

1/ Estimates of distribution of cattle marketings by feedlot capacity class were made for the 1969 production year from the census of agriculture and [12]. For all capacity classes of less than 1,000 head, estimates were based on annual marketings. Since the turnover rates in smaller capacity feedlots approach 1, annual marketings provide an adequate indication of capacity.

2/ The estimation procedure used distributes SRS estimates of fed-beef marketings by capacity classes derived from the census of agriculture. Rounding errors in the estimation procedure account for the small differences that are evident when the estimated State totals are compared with corresponding SRS reported marketings for these States.

3/ Illinois marketing estimates have been adjusted to reflect the deletion of marketings from certain small capacity operations to be consistent with currently used definitions.

4/ Values represent the combination of selected capacity categories from [12].

About half the cattle marketings in these 18 States came from 181,107 operations with capacities of less than 1,000 head. The balance came from 1,810 operations with capacities of more than 1,000 head.

Problem Fed-Beef Operations--University, Federal, and State agency personnel knowledgeable about problems of livestock waste management identified 48,833 U.S. fed-beef operations with surface water runoff problems; these account for 27 percent of all operations in these 18 States and account for 25 percent of the fed-beef cattle marketings in these States (tables 3 and 4). 2/ Three-fourths of the operations with problems had capacities of less than 100 head. Some 95 percent of the operations with runoff problems were in the Eastern States (table 3). About a third of the 1,810 U.S. operations with 1,000 or more head have runoff problems. Within this capacity category, only 139 of the 610 operations with runoff problems are in the Western States.

2/ Respondents estimated the percent of fed-beef operations that had surface water control problems occurring because of a continuous discharge and/or feedlot runoff entering a stream during or subsequent to a storm. Operations with a continuous discharge were those where: (1) the feedlot utilized a man-made drainage, flushing, or collecting system from which measurable water-borne wastes were regularly discharged, regardless of rains or melting snow, into a regularly flowing stream; (2) wastes were directly placed into a regularly flowing stream that traversed the feedlot; and/or (3) there was a frequent overflow from a waste retention facility. Feedlots with runoff problems were those from which runoff after a local 10-year, 24-hour storm would enter surface waters (see Appendix A for definitions of storm events). At a minimum, the operations identified are those which would have to make adjustments to be in compliance with the final effluent limitations guidelines for 1977.

Table 3--Number of fed-beef operations with runoff problems, by capacity class, 18 major States, 1972

State	Capacity class (head)					
	<100	100-199	200-499	500-999	1,000 and over	Total
	Number					
Pennsylvania	557	26	18	2	1	604
Ohio 1/	606	115	66	12	4	803
Indiana	1,988	111	53	10	1	2,163
Illinois	12,826	1,850	1,179	264	24	16,143
Iowa	1,387	353	301	67	7	2,115
Missouri	5,815	414	257	47	15	6,548
Michigan	155	46	30	8	2	241
Minnesota 1/	1,685	97	67	15	1	1,865
Wisconsin 1/	4,896	202	95	22	1	5,216
North Dakota 2/	622	112	51	7	13	805
South Dakota 2/	1,253	142	77	20	7	1,499
Nebraska	2,911	388	522	211	386	4,418
Kansas	3,428	392	180	21	9	4,030
Total	38,129	4,248	2,896	706	471	46,450

State	Capacity class (head)				
	<1,000	1,000-7,999	8,000-15,999	16,000 and over	Total
	Number				
Oklahoma	864	8	0	0	872
Texas	1,196	29	4	1	1,230
Colorado	141	18	6	8	173
California	43	52	9	4	108
Arizona 3/	--	--	--	--	--
Total	2,244	107	19	13	2,383

1/ Estimates of the number of fed-beef operations with surface water runoff problems were estimated from data on adjoining substate areas.

2/ Estimates were provided by personnel of the Soil Conservation Service, USDA.

3/ Respondents in Arizona noted a complete absence of surface water problems arising from fed-beef operations.

Table 4--Number of fed-beef marketings from operations with runoff problems, by capacity class, 18 major States, 1972

State	Capacity class (head)					
	<100	100-199	200-499	500-999	1,000 and over	Total
	Number					
Pennsylvania	2,145	3,612	5,614	2,511	4,340	18,222
Ohio	9,206	15,777	20,746	11,687	5,878	63,294
Indiana	28,501	15,386	16,014	8,344	6,267	74,512
Illinois	78,456	255,899	349,613	222,533	68,281	974,782
Iowa	68,311	48,387	88,735	51,021	20,774	277,228
Missouri	124,254	55,956	76,756	37,229	38,364	332,559
Michigan	10,903	6,611	9,719	7,139	4,812	39,184
Minnesota	19,466	13,204	20,679	13,190	2,183	68,722
Wisconsin	62,712	27,987	28,098	18,817	3,891	141,505
North Dakota	3,624	14,987	14,928	6,767	31,238	71,544
South Dakota	7,616	19,333	22,552	24,496	14,156	88,153
Nebraska	120,360	53,042	157,105	37,555	1,415,538	1,783,600
Kansas	96,485	61,918	55,599	15,302	47,720	277,024
Total	632,039	592,099	866,158	456,591	1,663,442	4,210,329

State	Capacity class (head)				
	<1,000	1,000-7,999	8,000-15,999	16,000- and over	Total
	Number				
Oklahoma	61,439	32,184	0	0	93,623
Texas	102,120	66,820	66,819	47,010	282,769
Colorado	39,649	94,760	100,000	486,080	720,489
California	4,250	87,500	114,000	168,000	373,750
Arizona 1/	--	--	--	--	--
Total	207,458	281,264	280,819	701,090	1,470,631

1/ Respondents in Arizona noted a complete absence of surface water problems arising from fed-beef operations.

LIMITATIONS FOR FEEDLOT RUNOFF

The Federal Water Pollution Control Act Amendments of 1972 established the goal to free navigable waters of pollutants from point sources by 1985. An interim goal is to provide a water quality suitable for fish, wildlife, and recreation by 1983 [3]. 3/ EPA was directed to establish effluent limitations guidelines for major industrial categories of point source discharges.

The amendments specify that by July 1, 1977, point source dischargers will comply with effluent limitations with application of the "best practicable control technology currently available." Not later than July 1, 1983, industries must meet effluent requirements with the "best available technology economically achievable" [3]. Substantial improvement in discharge quality is expected before these dates, according to the 1972 amendments [1].

Feedlots were established as one category of industrial point source dischargers [3]. Final effluent limitations guidelines for the feedlots point source category have been announced by EPA [6]: 4/

> After application of the best practicable control technology currently available there shall be no discharge of process wastewater pollutants to navigable waters except process wastewater pollutants in the overflow may be discharged to navigable waters whenever rainfall events, either chronic or catastrophic, cause an overflow of process wastewater from a facility designed, constructed, and operated to contain all process generated wastewaters plus the runoff from a 10-year, 24-hour rainfall for the location of the point source. (See Appendix A for definition of storm events.)
>
> After application of the best available technology economically achievable there shall be no discharge of process wastewater pollutants to navigable waters except process wastewater pollutants in the overflow may be discharged to navigable waters whenever rainfall events, either chronic or catastrophic, cause an overflow of process waste from a facility designed, constructed, and operated to contain all process generated wastewaters

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3/ Figures in brackets refer to references listed on page 37.

4/ These two guidelines apply to existing feedlots. The latter is also essentially the standard of performance for new entrants to the industry [6].

plus the runoff from a 25-year, 24-hour rainfall for the location of the point source. (See Appendix A for definition of storm events.)

EPA effluent limitations guidelines for the fed-beef industry are performance standards. The expected level of performance is "no discharge" of process wastewater pollutants to navigable waters. But overflow from the control systems (designed and operated in accordance with guidelines) caused by excessive, chronic, or catastrophic precipitation may be discharged without regard to pollutants in the overflow [6].

Since the EPA guidelines are performance rather than design standards, fed-beef operations can select from several types of runoff control systems. 5/ Operators will have broad flexibility to select control systems appropriate to local hydrologic data, soil conditions, weather conditions, and usual waste management practices. Similarly, guidelines do not specify operating criteria for the systems used. Feedlot operators can choose any operating method that provides control of runoff in accordance with guideline requirements [6].

Final guidelines for large feedlots became effective on April 15, 1974 [6]. Even though an earlier EPA announcement affected all sizes of fed-beef operations, final effluent limitations guidelines apply to those operations with production facilities with one-time capacities of 1,000 or more head of steers or heifers [5, 6]. EPA is currently analyzing possible limitations on smaller feeding operations; guidelines for these may be proposed later [6].

Implementation of the guidelines applicable to feedlots with capacities of 1,000 head or more will be achieved through the use of the National Pollutant Discharge Elimination System (NPDES) [4]. As provided in the Federal Water Pollution Control Act Amendments of 1972, the NPDES permit program will be administered initially at the Federal level, then through interim State programs, and ultimately through federally-approved but State-administered programs [3, pp. 65-68].

5/ System, as used in this report, refers to sets of physical facilities. Figure 2 depicts a four-component system. Under certain State guidelines, systems involving a different set of facilities are possible. Systems involving the same set of components, but components of different design capacity, i.e., dictating different management practices, are also considered distinguishable.

ECONOMIC IMPACTS OF GUIDELINES

This analysis was begun before passage of the 1972 amendments. It appraises the extent of point source water runoff control problems, estimates investments required and additional operating costs for control of surface water runoff, and evaluates aggregate supply and price effects of control guidelines.

The analysis considers two sets of runoff control guidelines. The first set was contained in a background report submitted to EPA as a partial basis for effluent guidelines development. Considered in this report was an available runoff control system capable of diverting extraneous flows around feeding areas, retaining runoff, and disposing of retained effluent on farmland [2]. A properly designed system would handle runoff anticipated from the local 10-year, 24-hour rainfall. Rainfall events exceeding this limit were considered not necessarily controllable. The background report also suggested that runoff facilities should be emptied over 5 days following the rainfall. The control system components identified in the background report to meet these requirements were a diversion terrace, a settling basin, a retention pond, and pump-irrigation equipment [2]. 6/

The background report guidelines analyzed differ from the final EPA guidelines in some aspects [2, 6]: The background report requires control of only the runoff from the 10-year, 24-hour storm, whereas final guidelines require control of process generated wastewater plus runoff from the 10-year, 24-hour storm (for the July 1, 1977, performance standard); the background report identifies a workable control technology, whereas final effluent guidelines allow feedlot operators free choice; and the background report specifies management practices, whereas final guidelines allow operators the flexibility of using any management practice consistent with the standard "no discharge."

Aggregate economic impact estimates for the background guidelines will probably differ little from estimates based on the final EPA guidelines for 1977. The quantity of surface water needing control was greater in the final guidelines. But these final guidelines allow more flexibility than the background guidelines in the selection of control systems and

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6/ It is assumed this suggested management practice for retention pond emptying had considered that "animal wastes should not be applied to farmlands under adverse soil conditions except when planned methods ensure that they remain on the land," as announced by EPA on January 14, 1972, in 'Policy on Control of Nutrient Runoff from Agricultural Lands.'"

management practices. These two factors will likely offset one another in the aggregate economic impacts. 7/

State guidelines were also considered in this study. Through provisions of the Water Quality Act of 1965, the States developed standards identifying streams and lakes according to particular uses, including water for human consumption, industrial consumption, recreation, and other uses. Each fed-beef producing State had water quality statutes or codes and implementation plans for the control of surface water runoff from fed-beef production facilities, according to a 1971 survey [8].

Runoff control systems used in major fed-beef producing States at the time of this analysis closely paralleled the control system identified in the background report. Systems usually featured some combination of the diversion terrace, settling basin, retention pond, and pump-irrigation equipment components. Design of the control systems varied, depending on the location and topography of fed-beef operations and prevailing climate. Settling basins were often not used where lot surfaces had minimal slope. Several States in the more humid production regions required fed-beef operations to design retention ponds to store anticipated runoff for up to 6 months to preclude land application when the land was frozen or snow covered. Pump-irrigation equipment was not required in every case for emptying retention ponds.

The impact estimates based on the State guidelines will not differ greatly from those based on the final EPA guidelines for 1983. 8/

7/ As the intent of the final effluent limitations guidelines is to control all surface waters, except runoff from unusual storms of a lower probability of recurrence than the 10-year, 24-hour rainfall, a larger capacity retention pond is required (necessitating a larger capital outlay in the range of $50 to $100 for a Michigan feedlot in the 200-499 head capacity class). However, as the final guideline is a performance standard, it may be possible to delete certain components which were specified in the background guidelines. For example, if a Michigan feedlot in the 200-499 head capacity class had topographic characteristics which would eliminate the need for a diversion terrace, total capital outlay could be reduced by $275 to $630 [9].

8/ State guidelines considered in the analysis reflect design criteria being used in the States during the 1972-73 period. Most State design guidelines provide for runoff storage facilities with capacities in excess of the 10-year, 24-hour rainfall and the 25-year, 24-hour rainfall (see table 6). The final guideline for 1983 calls for the control of process generated wastewater and runoff from the 25-year, 24-hour rainfall. As the intent of this final effluent limitations guideline is to control

Final effluent limitations guidelines currently apply to only fed-beef operations with one-time capacities of 1,000 head or more [6]. Estimates of the economic impacts on other capacity classes are presented in this study to give a preliminary assessment of the economic impacts for the entire industry. Final economic impact of runoff control on the fed-beef industry will depend on feedlot size criteria selected by EPA in the future and on the guidelines specified for feedlots with a one-time capacity of fewer than 1,000 head [6].

Capital Outlays and Additional Production Costs--Estimates are made of the added investments and production cost changes due to construction, ownership, and operation of runoff control systems designed according to background and State guidelines. Additional capital outlays of as much as $136 million and increased annual production costs of as much as $20.3 million could result.

Total costs of runoff control are not associated with the pounds of beef and wastes produced, but are associated with exposed feedlot surfaces and design storm events. The guidelines relate to the volume of runoff to be controlled rather than the quality of runoff or the degree of pollution of the receiving waters. The volume of runoff from a beef feedlot is determined primarily by the land area exposed to precipitation and the amount of precipitation (assuming extraneous flows are diverted from the feedlot). This is, of course, not the usual joint products situation where waste production is determined by the level of fed-beef production.

Capital outlays for runoff abatement facilities are more precisely stated as:

$I = (V)(R)(SF)(P)$, where

I = Investment in surface water abatement facilities;
V = Capacity of beef feeding facility;
R = Runoff from the local 10-year, 24-hour storm event, as specified in the background guidelines; or alternatively, the design storm specified in State guidelines;

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all surface waters except runoff from unusual storms of a lower probability of recurrence than the 25-year, 24-hour rainfall, it appears that retention facilities constructed according to State guideline criteria would be adequate for meeting this design criterion. It appears that the aggregate estimates based on State guidelines and those aggregate economic impacts attributable to the final 1983 effluent limitations guideline would be similar.

SF = Square feet of exposed lot surface per unit of capacity; and
P = Price per unit (i.e., cubic feet of control capacity, etc.) of control technology. 9/

If fed-beef operations do not change the capacity of existing feedlot facilities and do make the necessary capital outlay for runoff control systems, the additional costs for runoff control are essentially fixed costs. Once the control system is in place, annual total costs attributable to runoff control will not change with changes in the level of fed-beef production. 10/

9/ State staffs of the Soil Conservation Service provided planning design, construction, and per unit investment estimates for the runoff control systems considered. Per unit investment requirements, assuming all construction is performed by outside contractors, were provided to allow the estimation of capital outlays for diversion terraces, settling basins, and retention pond construction, fencing, and pond lining. Investment requirements for pump-irrigation equipment were made available through the Economic Research Service.

10/ For the above stated I, the total cost (TC) associated with this investment would be TC = (a + m)I, "a" being an amortization rate (capital recovery factor) and "m" a percentage maintenance charge.

INDUSTRY INVESTMENTS

While investments in runoff controls for the fed-beef industry could run as much as $136 million, the investments per head of feedlot capacity will be less for larger operations because of economies of size. There will also be differences in per head investments depending on the type of housing in use. Control systems under the background guidelines include a diversion terrace, settling basin, retention pond, and pump-irrigation equipment (figure 2). Under the State guidelines, control systems consist of some combination of these same four components. Component use varies according to the specific guidelines of each State.

Aggregate investments in control systems under the two sets of guidelines will not differ greatly--$132.8 million for the background guidelines and $135.6 million for State guidelines (table 5). However, composition of these totals varies considerably among the States. Major differences are:

1. Aggregate investment in retention ponds would be less under background guidelines than under State guidelines. Fencing and lining investments associated with retention structures would also be less under background guidelines.

2. The aggregate investment in pump-irrigation equipment would be greater under background guidelines than under State guidelines.

Under background guidelines, retention ponds must retain runoff from the local 10-year, 24-hour storm. It is assumed that runoff is equal in magnitude to local storm events. In the Eastern States, retention ponds designed according to background guidelines would have storage capacity equivalent to 11 to 22 percent of mean annual rainfall, depending on the sub-State area location (figure 3). State guidelines for these States provide for retention pond capacity ranging from 12 to 80 percent of mean annual rainfall (table 6). Guidelines in Western States provide for retention pond capacities ranging from 21 to 33 percent of mean annual rainfall.

Although most States recognize that runoff is less than precipitation for any storm event, States anticipate runoff subsequent to unusual (10-year, 24-hour) and normal storm events. State guidelines also recognize the pollution potential of runoff pumped from retention ponds, so retention ponds are being designed to retain runoff for relatively long time periods (up to 6 months). Investments in such structures increase in proportion to the length of the storage period.

Under the initial assumption of background guidelines, runoff equals precipitation; therefore, the quantity of runoff to be emptied equals the

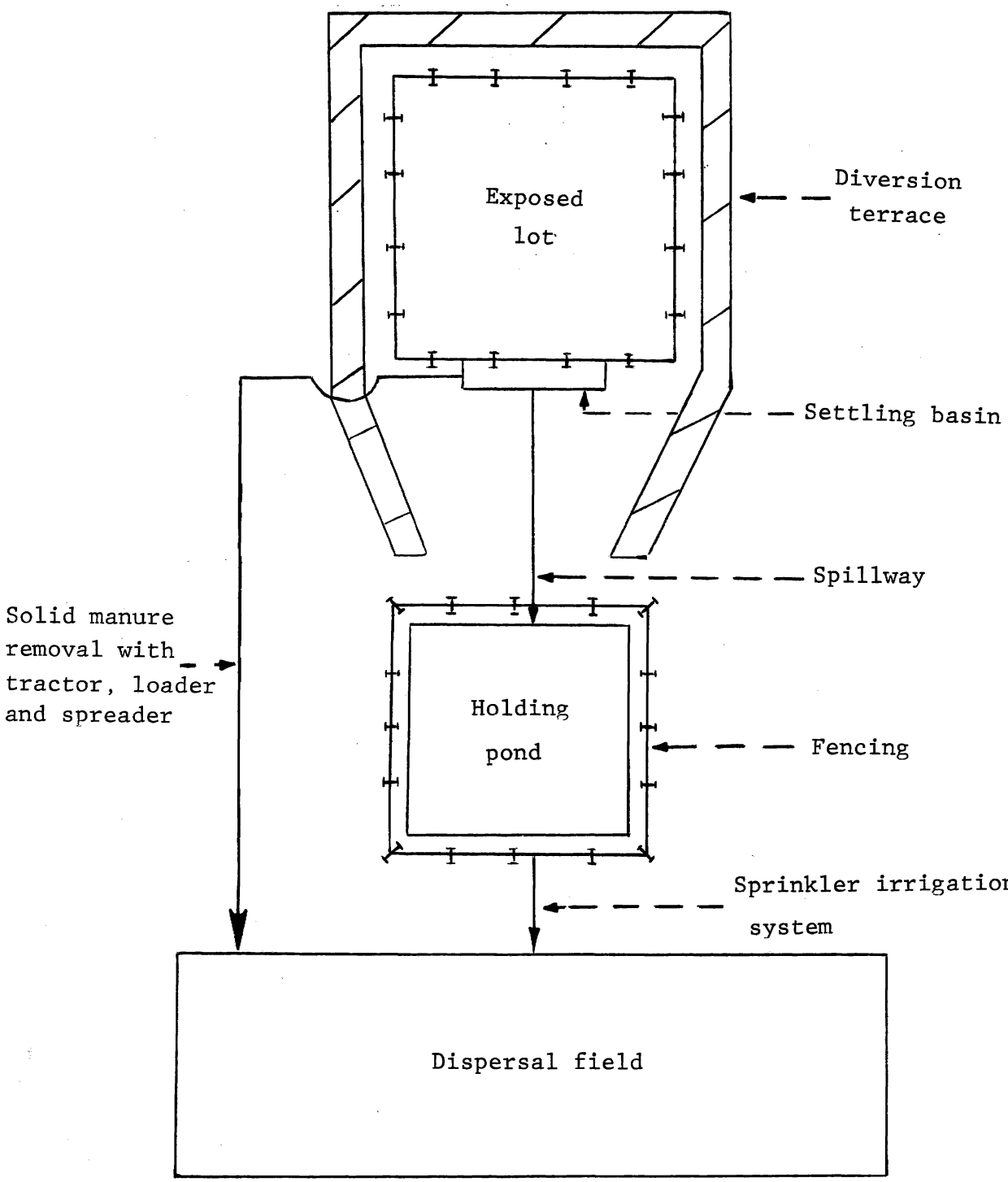

Figure 2--Four-component runoff control system exemplifying available technology

Table 5--Total and per head investments for runoff control systems, background and State guidelines, major fed-beef producing States, 1972

State	Total investment		Per head investment 1/	
	Background guidelines	State guidelines	Background guidelines	State guidelines
	$1,000		Dollars	
Pennsylvania	1,449	371	80.06	20.50
Ohio	2,122	327	33.52	5.16
Indiana	5,571	5,748	74.77	77.16
Illinois 2/	41,240	43,310	42.31	44.43
Iowa	6,256	6,234	22.57	22.48
Missouri 3/	16,471	16,916	49.52	50.84
Michigan	740	967	18.93	24.73
Minnesota	4,282	4,453	62.24	64.72
Wisconsin 2/	13,675	14,443	96.64	102.37
North Dakota	2,395	2,421	33.49	33.86
South Dakota	3,879	3,862	44.00	43.79
Nebraska	13,657	14,363	7.10	8.05
Kansas	11,488	12,637	41.46	45.62
Oklahoma	2,893	2,883	20.12	20.04
Texas	4,461	4,435	13.80	13.72
Colorado	1,561	1,561	2.16	2.16
California	646	622	1.73	1.66
Arizona 4/	--	--	--	--
Total	132,786	135,553		
Weighted average per head			23.00	23.48

1/ These estimates should not be extrapolated to the entire fed-beef industry, as weighting reflects the characteristics of fed-beef operations with surface runoff problems, and have distributional properties which deviate from those of the population of all fed-beef operations.

2/ In Illinois, 19 total-confinement fed-beef production systems were estimated to have surface water pollution problems. In Wisconsin, the 18 total-confinement fed-beef production systems with problems could probably solve runoff control problems with a change in management practices not involving the addition of runoff control facilities. As a consequence, the investments required for adjustment, if any, are not reflected in these and subsequent estimates.

3/ These estimates reflect a runoff control system designed to control only runoff from storm events and urine. As such, these systems would not correspond to current control systems in use in the State, as these are designed to receive a portion of the solid wastes and also provide storage capacity for urine and storm-induced runoff.

4/ Respondents in Arizona noted a complete absence of surface water problems arising from fed-beef operations.

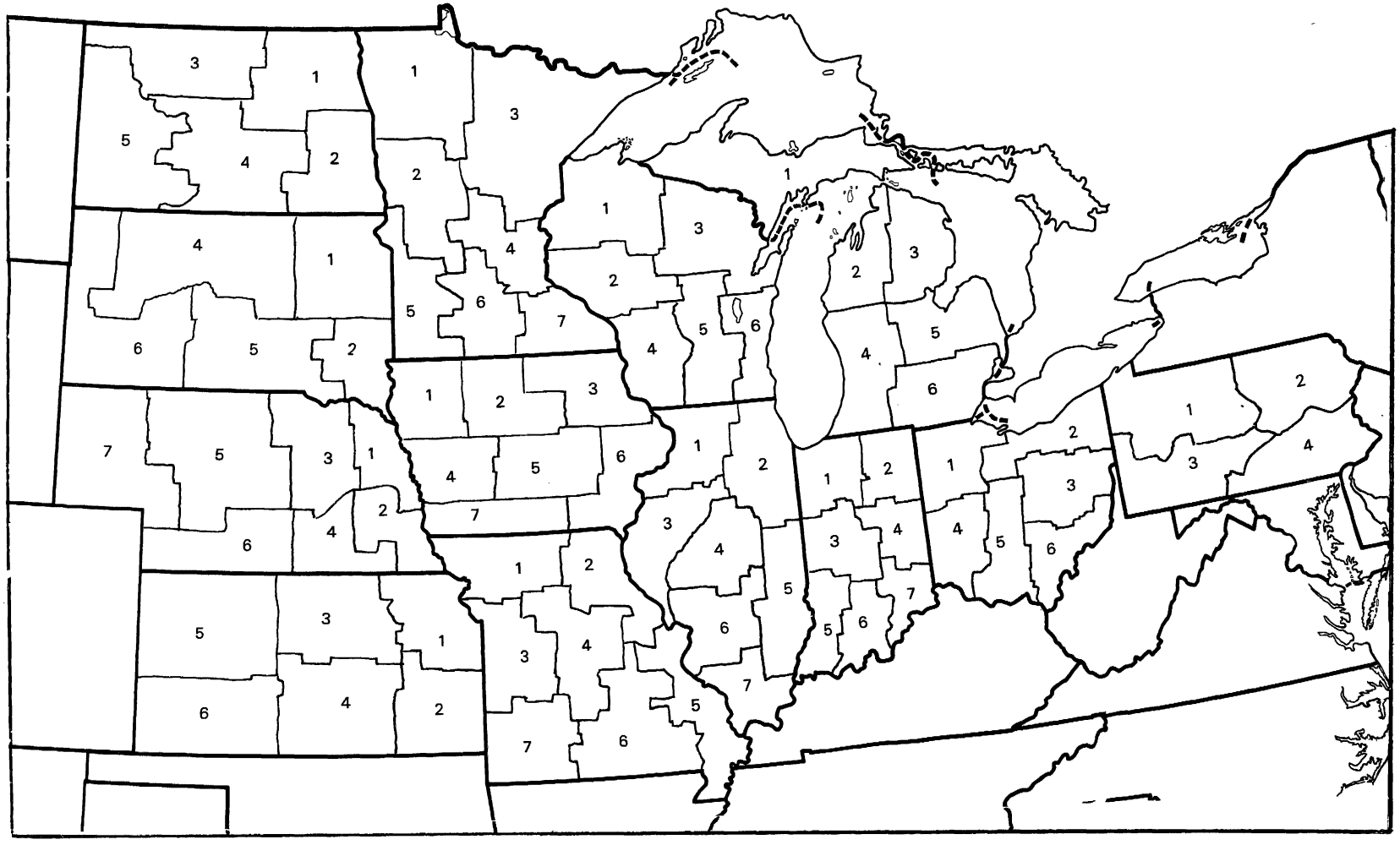

Figure 3--Identification of Soil Conservation Service administrative areas, Eastern States (identifies areas set forth in tables 6 and 7)

Table 6—Mean annual rainfall, retention pond runoff storage capacity, and retention pond storage capacity as a percentage of mean annual rainfall, by SCS administrative areas, State guidelines, Eastern States

SCS administrative area	Pennsylvania	Ohio	Indiana	Illinois	Iowa	Missouri	Michigan	Minnesota	Wisconsin	North Dakota	South Dakota	Nebraska	Kansas
						Mean annual rainfall (acre/feet)							
1	3.39	2.82	3.33	2.84	2.37	2.97	2.65	1.90	2.51	1.45	1.69	2.06	2.86
2	3.42	2.92	3.03	2.78	2.60	3.04	2.55	2.03	2.53	1.53	1.88	2.28	3.06
3	3.45	3.09	3.29	3.02	2.71	3.26	2.43	2.16	2.63	1.32	—	1.85	2.11
4	3.64	3.11	3.27	2.97	2.42	3.15	2.75	2.37	2.70	1.36	1.31	1.99	2.03
5	— 1/	3.22	3.52	3.31	2.63	3.67	2.44	2.00	2.57	1.32	1.50	1.65	1.60
6	—	3.44	3.64	3.29	2.77	3.57	2.66	2.25	2.50	—	1.39	1.68	1.46
7	—	3.27	3.53	3.57	2.65	3.46	—	2.44	—	—	—	1.37	—
						Retention pond runoff storage capacity (acre feet/acre of exposed surface)							
1	2.00	— 2/	1.00	1.15	.33	.75	1.32	3/.71	.83	.33	.29	.48	1.18
2	1.50	— 2/	1.00	1.15	.33	.75	1.18	.71	.83	.41	.29	.55	1.18
3	1.58	— 2/	1.00	1.15	.33	.75	1.18	.71	.83	.33	—	.42	1.18
4	1.83	— 2/	1.00	1.15	.33	.75	1.25	.71	.83	.33	.25	.48	1.18
5	—	— 2/	1.00	1.15	.33	1.00	1.08	.71	.83	.33	.29	.38	1.18
6	—	— 2/	1.00	1.15	.33	1.00	1.25	.71	.83	—	.25	.40	1.18
7	—	— 2/	1.00	1.15	.33	1.00	—	.71	—	—	—	.33	—
						Retention pond storage capacity/mean annual rainfall (percent)							
4/ 1	5/59	— 6/	30	41	14	26	57	38	33	23	17	23	41
2	44	— 6/	33	42	13	25	47	35	33	27	16	24	39
3	46	— 6/	30	38	12	23	49	33	31	25	—	23	56
4	50	— 6/	31	39	14	24	46	30	31	24	19	24	58
5	—	— 6/	28	35	13	28	45	36	32	25	20	23	74
6	—	— 6/	28	35	12	28	47	32	33	—	18	24	80
7	—	— 6/	28	32	13	29	—	29	—	—	—	24	—

1/ — Indicates that no SCS (Soil Conservation Service) administrative area of this numerical denotation exists within the State.

2/ No retention ponds currently in Ohio. However, such structures will be used in those instances where filter strips do not provide adequate runoff control.

3/ These values are for open-lot housing systems. The quantities of runoff storage is 2.04 feet for dry-lot paved systems and 1.58 feet for dry-lot unpaved housing systems.

4/ Refer to fig. 3, p. 17 for the location of substate areas.

5/ Rainfall data used in these calculations were derived by interpolation from data reported for State climatic regions in Climatic Atlas of the United States, U. S. Department of Commerce, Envir. Sci. Serv. Adm., June 1968.

6/ No percentages exist in Ohio because of reasons given in footnote 2.

mean annual precipitation. In addition, the background guidelines suggested that the retention pond be emptied over a 5-day period following a storm event. Under State guidelines, runoff pumped annually varied from 9 percent to 100 percent of mean annual rainfall (table 7). The lower amounts of runoff pumped and irrigated according to State guidelines reflect two considerations: (1) runoff quantities are generally less than precipitation, and (2) some evaporation of runoff does occur, especially in more arid areas (table 8).

Aggregate investments for diversion terraces and settling basins are similar under both background and State guidelines, since the design of such structures is independent of precipitation. The aggregate investment estimates under both sets of guidelines do not reflect the use of settling basins in Colorado and California, where this component has been excluded from most runoff control systems in current use. In these States, the retention pond is designed to allow for settling of solids. Capital outlays for retention ponds in these States are similar to combined capital outlays for retention ponds and settling basins constructed as separate structures.

Although aggregate investments for control systems include capital outlays for settling basins for fed-beef operations with runoff problems (California and Colorado fed-beef operations excluded), there are exceptions to this practice. In Indiana, only 10 percent of the systems have a settling basin component. Twenty percent of the North Dakota and 10 percent of the South Dakota systems have no settling basins. In Michigan, settling basins are considered useful only for dry-lot paved and open-lot housing systems.

In Pennsylvania and Ohio, aggregate investments for systems constructed in accordance with background guidelines are greater than those constructed in accordance with State guidelines. In Pennsylvania, retention ponds have been located where it is permissible to release runoff by gravity. Although pump emptying is becoming more prevalent in this State, investment estimates for pump-irrigation equipment are not included for State guidelines. In Ohio, grass drain fields have been used as a filter strip for runoff. Although retention ponds may receive increasing use in this State, most systems now use the filter strip as an alternative structure.

Aggregate investment requirements for the Western States reflect the need for pump-irrigation equipment for all runoff control systems. However, under current practices, some fed-beef operations do not use such equipment. In Texas, some 55 percent of the operations with runoff control systems do not use pump-irrigation equipment. Evaporation is sufficient to empty retention ponds in certain areas, especially where playa lakes (dried-up lake basins) are used for runoff storage.

Per Head Investment and Operation Capacity--Larger operations, within a specified housing type, realize lower investments per head capacity. Economies are realized in diversion terrace construction and in lining and

Table 7—Mean annual rainfall, quantities of runoff pumped annually, and runoff pumped annually as a percent of mean annual rainfall, by SCS administrative areas, State guidelines, major Eastern States

SCS administrative area	Pennsylvania	Ohio	Indiana	Illinois	Iowa	Missouri	Michigan	Minnesota	Wisconsin	North Dakota	South Dakota	Nebraska	Kansas
						Mean annual rainfall (acre/feet)							
1	3.39	2.82	3.33	2.84	2.37	2.97	2.65	1.90	2.51	1.45	1.60	2.06	2.86
2	3.42	2.92	3.03	2.78	6.20	3.04	2.55	2.05	2.53	1.53	1.88	2.28	3.06
3	3.45	3.09	3.29	3.02	2.71	3.26	2.43	2.16	2.65	1.32	—	1.85	2.11
4	3.64	3.11	3.27	2.97	2.42	3.15	2.75	2.37	2.70	1.36	1.31	1.99	2.03
5	— 1/	3.32	3.52	3.31	2.63	3.67	2.44	2.00	2.57	1.32	1.50	1.65	1.60
6	—	3.44	3.64	3.29	2.77	3.57	2.66	2.25	2.50	—	1.39	1.68	1.46
7	—	3.27	3.53	3.57	2.65	3.46	—	2.44	—	—	—	1.37	—
						Total runoff pumped annually (acre feet/acre of exposed surface) 2/							
1	— 3/	— 4/	2.00	2.30	1.32	1.50	2.65	1.42	.75	.13	.58	.48	1.26
2	— 3/	— 4/	2.00	2.30	1.32	1.50	2.36	1.42	.75	.15	.58	.55	1.26
3	— 3/	— 4/	2.00	2.30	1.32	1.50	2.36	1.42	.75	.13	—	.42	1.00
4	— 3/	— 4/	2.00	2.30	1.32	1.50	2.50	1.42	.75	.13	.50	.48	1.00
5	— 3/	— 4/	2.00	2.30	1.32	2.00	2.16	1.42	.75	.13	.58	.38	.87
6	— 3/	— 4/	2.00	2.30	1.32	2.00	2.50	1.42	.75	—	.50	.40	.87
7	— 3/	— 4/	2.00	2.30	1.32	2.00	—	1.42	—	—	—	.33	—
						Runoff pumped annually/mean annual rainfall (percent) 5/							
3/ 1	— 6/	— 6/	60	81	56	51	100	75	30	9	34	23	44
2	— 6/	— 6/	66	83	51	49	93	69	30	10	31	24	41
3	— 6/	— 6/	61	76	49	46	97	66	28	10	—	23	47
4	— 6/	— 6/	61	77	55	48	91	60	28	10	38	24	49
5	—	— 6/	57	70	50	55	89	71	29	10	39	23	54
6	—	— 6/	55	70	48	56	94	63	30	—	36	24	60
7	—	— 6/	57	64	50	58	—	58	—	—	—	24	—

1/ — Indicates that no SCS administrative area of this numerical denotation exists within the State.

2/ These values are for open-lot housing systems. The annual quantities of runoff pumped for dry-lot paved systems are 4.08 feet annually and 3.16 feet annually for dry-lot unpaved systems.

3/ Emptying is by gravity flow and is practiced where technically possible. However, pumping is necessary in some locations.

4/ No retention ponds currently in Ohio. However, such structures will be used in those instances where filter strips do not provide adequate runoff control.

5/ Rainfall data used in these calculations were derived by interpolation from data reported for the State climatic regions in Climatic Atlas of the United States, U. S. Department of Commerce, Envir. Sci. Serv. Admin., June 1968.

6/ No percentages exist for Pennsylvania and Ohio because of reasons given in footnotes 3 and 4.

fencing retention ponds. No economies are realized in retention pond and settling basin excavation. There are few economies in the acquisition prices of excavation, seeding, or other services; identical per unit charges by contractors were assumed for feedlots of all capacity levels.

Table 8--Mean annual rainfall, retention pond capacity, runoff pumped annually, and pond capacity and runoff pumped as a percentage of mean annual rainfall, State guidelines, Western States

State	Mean annual rainfall 1/	Retention pond capacity	Retention pond capacity/ mean annual rainfall	Runoff pumped annually	Runoff pumped/ mean annual rainfall
	Acre feet	Acre feet/ acre of feedlot	Percent	Acre feet/ acre of feedlot	Percent
Oklahoma	1.92	.40	21	0.50	26
Texas	1.92	.40	21	0.50	26
Colorado	1.00	.31	31	0.16	16
California	1.00	.33	33	0.17	17
Arizona 2/	--	--	--	--	--

1/ These are weighted mean annual rainfall estimates, based on historical mean annual rainfalls in major beef feeding areas. These values do not necessarily reflect mean annual rainfalls for each State, taken in its entirety.

2/ Respondents in Arizona noted a complete absence of surface water problems arising from fed-beef operations.

Since runoff must be emptied from ponds over a 5-day period following a 10-year, 24-hour storm event under the background guidelines, pump-irrigation equipment would be required. Such equipment would require a minimum capital outlay of $2,150 to $2,500 for most fed-beef operations. (The capital outlays for pump-irrigation equipment might be less for some operations with less than 100-head capacities.) Investments in pump-irrigation equipment become more burdensome if runoff has to be pumped more than 500 feet from retention ponds for irrigation. Because of the

large capital outlays for pump-irrigation equipment high per head capital outlays are found with fed-beef operations with less than 1,000 head capacities in the Western States (tables 9 and 10). But these high per head costs are not as pronounced as those on small capacity fed-beef operations in the Eastern States (table 9).

Pump-irrigation equipment investments made in accordance with State guidelines also assume equipment ownership. Again, relatively high per head capital outlays are found with lower capacity operations. In the Eastern States, some operators lease pump-irrigation equipment to reduce capital outlay requirements [11]. Other producers have entered into joint ownership agreements for pump-irrigation equipment.

Investments for Land-Extensive Lots--For fed-beef operations of equal capacity in a particular State, different types of housing require varying investments for runoff control systems. Under given precipitation conditions, capital outlays for retention pond fencing and lining increase considerably for land-extensive housing facilities. Diversion terrace length and settling basin size depend on the area of exposed feedlot. Capital outlays for diversion terraces and settling basins are greatest for open-lot housing systems and lowest for the land-intensive, dry-lot paved housing systems. 11/

In the Eastern States, per head investments within each feedlot capacity class are generally highest for land-extensive, open-lot systems; lowest for dry-lot paved systems; and intermediate for dry-lot unpaved systems (table 11). In such humid areas, land-extensive operations have more runoff to control, pump, and distribute. Greater runoff quantities not only increase retention pond and associated fence and lining investments, but may also require larger pump-irrigation equipment. Therefore, larger per head investments are generally incurred by open-lot systems within each capacity class (table 12).

11/ University, Federal, and State agency personnel knowledgeable about fed-beef production were asked to provide the distributions of housing types for each capacity class based on their knowledge of cattle feeding within their State. Housing type distributions were estimated by respondents for the SCS administrative areas within each State. For a description of the four housing types considered, see Appendix B.

Table 9--Investments for runoff control, total and per head, by capacity class, background and State guidelines, 1972

Capacity class (head) by region	Background guidelines		State guidelines	
	Total	Per head 1/	Total	Per head 1/
	$1,000	Dollars	$1,000	Dollars
Eastern States:				
<100	91,789	145.20	90,964	143.93
100-199	12,435	21.00	13,122	22.17
200-499	10,053	11.60	11,023	12.73
500-999	3,736	8.18	4,481	9.82
1,000 and over	5,212	3.13	6,462	3.88
Western States:				
<1,000	7,413	21.65	7,388	21.60
1,000- 7,999	771	2.92	741	2.81
8,000-15,999	434	1.61	431	1.60
16,000 and over	943	1.38	941	1.37

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

Table 10--Investment required for runoff control, by capacity class, background and State guidelines, Western States, 1972

State	Background guidelines				
	<1,000	1,000-7,999	8,000-15,999	16,000 and over	Weighted average
	Dollars per head				
Oklahoma	25.05	3.12	0	0	1/ 20.12
Texas	21.55	4.26	2.59	2.41	13.80
Colorado	11.85	2.15	1.69	1.48	2.16
California	29.75	2.85	1.08	0.88	1.73
Arizona 2/	--	--	--	--	--

State	State guidelines				
	<1,000	1,000-7,999	8,000-15,999	16,000 and over	Weighted average
	Dollars per head				
Oklahoma	24.97	3.06	0	0	1/ 20.05
Texas	21.45	4.19	2.52	2.34	13.72
Colorado	11.82	2.15	1.69	1.48	2.16
California	29.75	2.57	1.08	0.88	1.66
Arizona 2/	--	--	--	--	--

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

2/ Respondents in Arizona noted a complete absence of surface water problems arising from fed-beef operations.

Table 11--Investment for runoff control (dollars per head), by capacity class, by housing type, background guidelines, Eastern States, 1972 1/

Housing type	Pennsylvania	Ohio	Indiana	Illinois	Iowa	Missouri	Michigan	Minnesota	Wisconsin	North Dakota	South Dakota	Nebraska	Kansas
<100 head capacity													
Open-lot	756.57	177.92	206.72	450.21	54.06	113.43	42.42	178.94	204.03	-- 2/	397.32	56.56	93.48
Dry-lot paved	548.66	149.22	156.43	361.60	46.95	--	33.53	188.11	176.10	419.99	--	--	87.32
Dry-lot unpaved	634.41	152.83	177.37	383.56	53.84	--	42.38	194.19	191.45	469.34	409.88	57.02	97.17
Weighted average	593.09	154.16	173.61	378.14	52.91	113.43	38.74	193.83	189.82	468.55	399.90	56.56	94.55
100-199 head capacity													
Open-lot	--	46.84	34.03	37.22	22.79	20.65	23.28	24.60	37.44	--	21.04	19.22	28.83
Dry-lot paved	19.16	18.52	18.28	18.08	17.85	--	17.34	17.67	21.47	20.11	--	--	18.00
Dry-lot unpaved	22.67	28.28	24.21	21.85	22.23	--	22.92	18.26	34.14	23.72	21.37	19.35	13.42
Weighted average	23.93	20.60	21.74	20.18	21.94	20.65	20.86	18.49	31.29	23.65	21.11	19.22	20.87
200-499 head capacity													
Open-lot	--	37.61	23.45	27.40	12.88	11.53	13.81	15.24	28.65	--	11.16	9.85	13.25
Dry-lot paved	10.27	9.49	9.47	9.54	9.24	--	8.66	8.85	12.86	10.44	--	--	10.38
Dry-lot unpaved	12.83	18.53	14.06	13.06	12.18	9.53	12.79	9.21	25.61	12.33	11.19	9.88	13.42
Weighted average	11.29	11.36	11.73	11.52	12.30	11.41	11.46	9.44	19.41	12.29	11.17	9.85	13.22
500-999 head capacity													
Open-lot	--	--	--	20.73	7.85	5.84	--	--	22.51	--	4.78	6.24	8.13
Dry-lot paved	5.29	5.15	4.93	4.77	4.48	--	4.44	--	8.06	--	--	--	--
Dry-lot unpaved	7.79	14.01	9.05	7.90	7.16	4.86	7.46	4.54	20.56	5.92	--	6.24	8.10
Weighted average	6.78	6.94	7.57	7.77	7.51	5.79	6.30	4.54	15.13	5.89	4.78	6.24	8.10
1,000 head and over capacity													
Open-lot	--	30.71	14.26	18.17	5.07	3.37	6.04	--	20.13	--	4.04	2.62	4.48
Dry-lot paved	--	4.24	3.06	2.92	--	--	--	--	--	--	--	--	--
Dry-lot unpaved	4.67	--	--	5.85	--	--	5.45	3.17	--	3.87	--	--	4.32
Weighted average	4.67	10.32	5.99	9.55	5.07	3.37	5.67	3.17	20.13	3.85	4.04	2.62	4.47
State weighted average	79.50	33.52	74.77	42.31	22.57	49.52	18.90	62.31	96.92	33.49	44.00	7.66	41.46

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

2/ -- Indicates there were no operations in these capacity-housing type classes that had runoff control problems.

Table 12—Investment for runoff control (dollars per head), by capacity class, by housing type, State guidelines, Eastern States, 1972 1/

Housing type	Pennsylvania	Ohio	Indiana	Illinois	Iowa	Missouri	Michigan	Minnesota	Wisconsin	North Dakota	South Dakota	Nebraska	Kansas
						<100 head capacity							
Open-lot	101.17	34.97	215.47	462.17	54.06	115.36	52.92	183.13	218.39	--2/	397.32	57.21	94.45
Dry-lot paved	34.44	3.14	157.46	363.18	46.95	--	35.41	191.20	178.34	420.57	--	---	90.07
Dry-lot unpaved	75.48	14.37	181.10	387.40	53.84	--	51.08	197.49	195.59	470.31	409.88	57.67	102.14
Weighted average	55.40	10.78	176.92	381.46	52.91	115.36	44.70	197.15	195.78	469.51	399.91	57.21	99.41
						100-199 head capacity							
Open-lot	--	26.44	41.53	46.51	22.79	22.11	33.08	27.49	50.52	--	20.49	19.19	24.94
Dry-lot paved	10.12	2.24	18.97	18.92	17.85	--	19.00	19.86	23.29	20.43	--	--	19.89
Dry-lot unpaved	22.39	10.18	26.62	24.34	21.69	--	31.40	20.64	37.68	23.77	20.82	19.32	25.45
Weighted average	16.41	3.96	23.54	21.94	21.61	22.11	26.83	20.88	34.96	23.71	20.36	19.19	24.87
						200-499 head capacity							
Open-lot	--	25.82	30.10	36.46	12.83	12.01	22.97	17.73	41.17	--	11.14	10.10	16.73
Dry-lot paved	9.19	2.17	10.10	10.32	9.06	--	10.18	10.68	14.62	10.49	--	--	12.53
Dry-lot unpaved	20.19	9.86	16.90	15.45	12.18	10.24	20.62	11.23	28.79	12.65	11.16	10.12	16.90
Weighted average	13.59	3.75	13.41	14.92	12.27	11.90	17.25	11.46	24.07	12.61	11.15	10.10	16.66
						500-999 head capacity							
Open-lot	--	--	--	29.59	7.83	7.03	--	--	35.61	--	4.62	6.57	12.16
Dry-lot paved	8.57	2.14	5.43	5.49	4.48	--	5.77	--	9.68	--	--	--	--
Dry-lot unpaved	19.32	9.71	11.50	10.07	7.00	5.23	14.93	6.67	23.83	6.19	--	6.57	12.13
Weighted average	14.98	3.67	9.38	9.95	7.44	6.94	11.42	6.67	20.31	6.16	4.62	6.57	12.14
						1,000 head and over capacity							
Open-lot	--	24.45	21.25	26.90	5.07	4.54	14.37	--	33.17	--	3.95	3.03	8.28
Dry-lot paved	--	2.14	3.59	3.60	--	--	--	--	--	--	--	--	--
Dry-lot unpaved	18.20	--	--	8.07	--	--	12.60	5.14	--	4.32	--	--	--
Weighted average	18.20	7.49	8.21	13.72	5.07	4.54	13.26	5.53	33.17	4.29	3.95	3.03	8.27
State weighted average	20.37	5.16	77.16	44.43	22.48	50.87	24.67	64.80	102.37	33.59	43.81	8.05	45.62

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

2/ — Indicates there were no operations in these capacity-housing type classes that had runoff control problems.

ANNUAL ADDED PRODUCTION COSTS

Total additional annual costs of fed-beef production will not differ greatly under background guidelines ($19.3 million) or State guidelines ($20.3 million) (table 13). Higher ownership costs associated with generally larger investments in retention ponds, lining, and fencing under State guidelines are offset by higher costs associated with pump-irrigation equipment under background guidelines. Ownership costs will include an opportunity cost on equity and interest on borrowed capital, depreciation allowances, repairs, real and personal property taxes, and casualty insurance premiums. Net ownership costs will depend on the income tax position of each operator. Ownership costs were estimated uniformly for all feedlots. Amortization rates reflecting a 7.5-percent interest rate and a 20-year life were applied to all investments, except the pump-irrigation equipment, which was assigned a 10-year life. An annual repair and maintenance charge of 1 percent was included in ownership costs.

Operating costs will be incurred for the pump-irrigation equipment and for the periodic removal of settling basin solids. However, costs of removing these solids are not viewed as additional costs directly attributable to runoff control. Solids removed from the settling basin would have otherwise been removed from lot surfaces, and most operators already have conventional manure spreaders and front-end loaders which could be used to clean settling basins. Therefore, no net additional operating or ownership costs are incurred in removing solids from the feedlot facility.

Cost Per Head for Larger Operations--Larger operations will have lower ownership costs per head marketed because of investment economies realized for diversion terraces, retention pond lining, and retention pond fencing (table 14). In the Eastern States, the range for State guidelines is from a $20.56 per head increase for operations of less than 100 head to $0.54 per head increase for operations of more than 1,000 cattle.

Subsequent changes in the level of beef production on each operation will not affect the total costs of runoff control, since the total costs of runoff control become fixed after the control system is installed. But runoff control costs will not be uniform among fed-beef operations. Costs per head marketed will generally be lower for larger capacity operations than for smaller capacity operations. In the Eastern States, annual costs per head marketed will be $0.69 for operations with capacities of 1,000 head or more under the background guidelines. For operations with capacities of 100 to 199 head in these States, annual costs per head marketed are estimated at $3.19.

In the Western States, under the background guidelines, operations with capacities of 1,000 to 7,999 head can expect annual cost increases of

Table 13--Increased production costs for runoff control, background and State guidelines, major beef-feeding States, 1972

State	Total cost		Per head cost 1/	
	Background guidelines	State guidelines	Background guidelines	State guidelines
	Dollars			
Pennsylvania	210,800	40,100	11.65	2.22
Ohio	305,200	35,300	4.82	.56
Indiana	800,200	811,200	10.74	10.89
Illinois	5,945,500	6,131,400	6.11	6.30
Iowa	976,300	915,400	3.52	3.30
Missouri	2,536,000	2,476,600	7.63	7.45
Michigan	114,600	138,300	2.92	3.53
Minnesota	629,500	639,000	9.16	9.29
Wisconsin	1,945,100	1,998,100	13.75	14.12
North Dakota	350,500	330,500	4.90	4.62
South Dakota	570,900	550,700	6.47	6.25
Nebraska	2,442,900	2,064,100	1.37	1.16
Kansas	1,761,700	1,784,400	6.36	6.44
Oklahoma	470,000	417,900	4.65	4.14
Texas	747,900	640,800	2.64	2.27
Colorado	345,700	212,200	0.47	0.29
California	161,900	94,200	0.43	0.25
Arizona 2/	--	--	--	--
Total	20,314,700	19,280,200	3.57	3.39

1/ These estimates should not be extrapolated to the entire fed-beef industry, because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties that deviate from those of the population of all fed-beef operations. (These estimates are per-head marketed, thus reflecting turnover rates where annual volume exceeds one-time capacity.)

2/ Respondents in Arizona noted a complete absence of surface water problems arising from fed-beef operations.

$0.57 per head marketed. In comparison, operations with capacities of less than 1,000 head can expect annual cost increases of $5.79 per head marketed.

Cost differences per head marketed for operations of similar capacities but in different production regions are unlikely to generate geographic shifts in production. Localized economies in the costs of fed-beef production would likely overshadow the nominal differentials in runoff control costs.

Table 14--Increased production costs for runoff control by capacity class, background and State guidelines, 1972

Capacity class (head) by region	Background guidelines		State guidelines	
	Total	Per head 1/	Total	Per head 1/
	Dollars			
Eastern States:				
<100	13,383,300	21.17	12,993,800	20.56
100-199	1,890,400	3.19	1,859,000	3.14
200-499	1,588,400	1.84	1,557,900	1.79
500-999	584,500	1.28	611,400	1.33
1,000 and over	1,142,600	0.69	893,000	0.54
Western States:				
<1,000	1,201,000	5.79	1,068,500	5.15
1,000- 7,999	160,300	0.57	107,400	0.38
8,000-15,999	112,000	0.40	60,800	0.22
16,000 and over	252,200	0.36	128,400	0.18

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

Costs for Dry-lot Paved Systems--For operations of equal capacity in any given State, per head cost increases for runoff control are generally lower for dry-lot paved systems than for dry-lot unpaved and open-lot systems (tables 15 and 16). Increased production costs for land-extensive housing systems are attributable to ownership costs associated with higher investments for retention pond excavation, fencing, and lining, and higher costs associated with the ownership and operation of pump-irrigation equipment.

Table 15—Increased production costs for runoff control (dollars per head marketed), by capacity class, by housing type, background guidelines, Eastern States, 1972

Housing type	Pennsylvania	Ohio	Indiana	Illinois	Iowa	Missouri	Michigan	Minnesota	Wisconsin	North Dakota	South Dakota	Nebraska	Kansas
						<100 head capacity							
Open-lot	108.54	25.56	29.21	63.02	8.19	16.92	6.41	26.36	29.32	— 2/	56.77	8.61	13.92
Dry-lot paved	79.47	21.71	22.66	52.43	6.88	—	4.91	27.40	25.49	59.60	—	—	12.79
Dry-lot unpaved	91.21	22.09	25.29	55.00	8.05	—	6.31	28.27	27.27	65.19	58.13	8.65	14.32
Weighted ave. 1/	85.55	22.34	24.83	54.37	7.92	16.92	5.74	28.25	27.20	65.10	57.05	8.61	14.01
						100-199 head capacity							
Open-lot	—	6.55	5.20	5.43	3.60	3.50	3.74	4.15	5.37	—	3.24	3.08	3.43
Dry-lot paved	2.86	2.68	2.66	2.62	2.67	—	2.57	2.67	3.04	3.04	—	—	2.81
Dry-lot unpaved	3.43	3.99	3.57	3.21	3.45	—	3.61	2.81	4.52	3.58	3.27	3.10	3.48
Weighted ave. 1/	3.60	2.96	3.20	2.95	3.41	3.50	3.23	2.86	4.24	3.57	3.25	3.08	3.42
						200-499 head capacity							
Open-lot	—	5.04	3.55	3.90	2.20	2.06	2.29	2.63	3.97	—	1.85	1.74	2.27
Dry-lot paved	1.54	1.37	1.39	1.39	1.40	—	1.32	1.35	1.79	1.61	—	—	1.73
Dry-lot unpaved	2.04	2.59	2.14	1.89	2.04	.64	2.16	1.44	3.23	2.02	1.85	1.74	2.28
Weighted ave. 1/	1.74	1.62	1.75	1.67	2.07	2.04	1.88	1.49	2.62	2.01	1.85	1.74	2.24
						500-999 head capacity							
Open-lot	—	—	—	2.98	1.37	1.26	—	—	3.10	—	.87	1.20	1.50
Dry-lot paved	.83	.72	.71	.68	.71	—	.68	—	1.07	—	—	—	—
Dry-lot unpaved	1.25	1.87	1.37	1.13	1.23	.90	1.35	.76	2.49	1.06	—	1.20	1.49
Weighted ave. 1/	1.08	.95	1.13	1.11	1.30	1.24	1.09	.76	1.98	1.06	.87	1.20	1.49
						1,000 and over head capacity							
Open-lot	—	4.03	2.30	2.63	.98	.90	1.19	—	2.77	—	.76	.62	1.05
Dry-lot paved	—	.59	.44	.40	—	—	—	—	—	—	—	—	—
Dry-lot unpaved	.82	—	—	.83	—	—	1.06	.54	—	.77	—	—	1.03
Weighted ave. 1/	.82	1.38	.92	1.37	.98	.90	1.11	.54	2.77	.77	.76	.62	1.05
State weighted average 1/	11.58	4.82	10.74	6.11	3.52	7.63	2.92	9.16	13.79	4.90	6.47	1.37	6.36

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

2/ — Indicates there were no operations in these capacity-type classes that had runoff control problems.

Table 16—Increased production costs for runoff control (dollars per head marketed), by capacity class, by housing type, State guidelines, Eastern States, 1972

Housing type	Pennsylvania	Ohio	Indiana	Illinois	Iowa	Missouri	Michigan	Minnesota	Wisconsin	North Dakota	South Dakota	Nebraska	Kansas
						<100 head capacity							
Open-lot	10.93	3.78	29.67	64.05	7.85	16.70	7.49	25.84	30.26	— 2/	56.46	8.27	13.94
Dry-lot paved	3.72	.34	22.74	52.58	6.80	—	5.10	27.65	25.65	59.43	—	—	12.83
Dry-lot unpaved	8.15	1.55	25.51	55.35	7.77	—	7.25	28.49	27.55	64.83	57.81	8.32	14.34
Weighted ave. 1/	5.99	1.16	25.02	54.67	7.65	16.70	6.38	28.43	26.60	64.75	56.74	8.27	14.03
						100-199 head capacity							
Open-lot	—	2.86	5.65	6.26	3.34	3.33	4.74	3.76	6.33	—	1.97	2.79	3.53
Dry-lot paved	1.09	.24	2.70	2.69	2.60	—	2.74	2.82	3.15	2.84	—	—	2.86
Dry-lot unpaved	2.42	.10	3.75	3.43	3.24	—	4.48	2.92	4.74	3.23	2.00	2.81	3.58
Weighted ave. 1/	.77	.43	3.32	3.10	3.20	3.33	3.84	2.95	4.45	3.22	1.98	2.79	3.51
						200-499 head capacity							
Open-lot	—	2.79	4.06	4.74	1.94	1.90	3.27	2.34	4.94	—	1.61	1.48	2.39
Dry-lot paved	.99	.23	1.42	1.45	1.33	—	1.48	1.50	1.89	1.44	—	—	1.78
Dry-lot unpaved	2.19	1.07	2.31	2.11	1.83	1.55	2.99	1.57	3.46	1.70	1.61	1.48	2.40
Weighted ave. 1/	1.47	.41	1.86	1.82	1.85	1.88	2.50	1.59	2.96	1.69	1.61	1.48	2.37
						500-999 head capacity							
Open-lot	—	—	—	3.80	1.18	1.13	—	—	4.14	—	.68	.96	1.68
Dry-lot paved	.93	.23	.74	.74	.65	—	.82	—	1.18	—	—	—	—
Dry-lot unpaved	2.09	1.05	1.55	1.34	1.07	.83	2.12	.89	2.73	.80	—	.96	1.68
Weighted ave. 1/	1.62	.40	1.26	1.31	1.13	1.12	1.62	.89	2.38	.80	.68	.96	1.68
						1,000 head and over capacity							
Open-lot	—	2.75	2.77	3.43	.79	.78	2.05	—	3.78	—	.58	.43	1.16
Dry-lot paved	—	.23	.47	.47	—	—	—	—	—	—	—	—	—
Dry-lot unpaved	1.97	—	—	1.03	—	—	1.80	.67	—	.54	—	—	1.14
Weighted ave. 1/	1.97	.81	1.07	1.75	.79	.78	1.89	.67	3.78	.54	.58	.43	1.16
State weighted average 1/	2.20	.56	10.89	6.30	3.30	7.45	3.53	9.44	14.16	4.62	6.25	1.16	6.44

1/ These estimates should not be extrapolated to the entire fed-beef industry because weighting of this subpopulation reflects the characteristics of fed-beef operations with surface runoff problems. They may therefore have distributional properties different from those of the population of all fed-beef operations.

2/ — Indicates there were no operations in these capacity-type classes that had runoff control problems.

IMPLICATIONS FOR INDIVIDUAL PRODUCERS, THE FED-BEEF INDUSTRY, AND ENVIRONMENTAL QUALITY

Reactions of each fed-beef producer to EPA guidelines cannot be fully determined from available information. Additional knowledge about the relationship between production systems and costs of production, the equity position of the fed-beef producer, and access to capital sources would be needed. Also, the operator's expectations about fed-beef and input prices must be considered. Such expectations depend partly on industry adjustments occurring during and after compliance with effluent guidelines.

Additional costs will be incurred by fed-beef operations which invest in runoff control systems. Per head cost increases will be substantial for smaller capacity operations. Within the same capacity class in the Eastern States, runoff control costs are generally greatest for the land-extensive, open-lot systems and lowest for the land-intensive, dry-lot paved systems. In Illinois, open-lot operations with capacities of 100 to 199 head can expect increased annual per head costs of $5.43 under the background guidelines. Dry-lot paved operations of similar capacity can expect annual per head cost increases of $2.62. Operators might therefore consider a change in the type of housing to reduce per head costs of runoff control. But the willingness of a producer to shift from an open-lot system with relatively low capital investment to a production system with relatively high capital investment, such as the dry-lot paved housing system, will depend on a number of factors in addition to runoff control. Among these will be the remaining useful life of existing facilities, as well as the differences in labor requirements, feed efficiency, and capital requirements. Additionally, waste management features other than runoff control will also need to be considered.

Implementing background and State guidelines could result in annual cost increases which could jeopardize the economic position of smaller capacity operations, especially those with land-extensive housing systems in humid production regions. Operators' choices of runoff control technology which make the best use of the physical characteristics of their existing production facilities will reduce these adverse effects.

EPA, in announcing the guidelines as performance standards, recognized that alternative forms of runoff control structures are available. Among these are holding basins, ponds, and lagoons for containing and partially stabilizing wastes; anaerobic lagoon systems; modified sludge concepts; and oxidation ditches for handling and partial treatment of wastes. Land use through irrigation, bulk liquid spreading, or bulk solids spreading is encouraged for completion of the waste management cycle [5]. EPA thus allows fed-beef operators to select control means which more efficiently use existing resource bases in meeting the effluent limitations guidelines.

The only criterion is that the control system selected yields effluent that meets water quality standards [5, 6].

Guidelines established by EPA give fed-beef operators flexibility in selecting control systems that could result in more economic solutions than those estimated for background and State guidelines. The aggregate industry impacts for runoff control, measured in capital outlays and production cost increases, could be less than those estimated under guidelines considered in this analysis.

Although interim goals of the Federal Water Pollution Control Act Amendments of 1972 allow for some point source discharges, the ultimate goal is elimination of all industrial discharges, including those of the feedlots point source industrial category [3]. But the prohibition of all feedlot runoff entering surface waters overlooks the fundamental point that receiving waters have some biological, chemical, and hydrological capacities for self-cleansing. If no feedlot runoff entered surface waters, the self-cleansing capacities of these systems could be underutilized. Conversely, this implies that too many resources could be expended to prevent runoff from entering surface waters.

A predecessor agency of EPA recognized the need for empirically estimating the effluent levels arising from fed-beef operations (including variables to measure the quantity and quality of effluents, as indicated by biological oxygen demand values) [13]. This agency found that, on a gross basis, amounts of pollutants reaching watercourses are not measures of actual pollution, but do indicate upper limits of the pollution problem [13]. It was stated that, on a case-by-case basis, the amount of pollutants reaching a watercourse could be related to the receiving stream's flow and other dilution factors to obtain a good estimate of pollution potential [13].

In our analysis, fed-beef operations were stratified by geographic location, feedlot capacity, and type of housing. Using rainfall data for the geographic locations, the quantities of runoff controlled by operations with installed control systems were estimated by capacity of operation (table 17).

The gallons of runoff controlled by operable control systems might be viewed as an indicator of the upper limit of the damages previously inflicted on society. Actual damage inflicted on society prior to runoff control is not known. Knowledge of only the quantity of runoff controlled does not provide a complete indicator of surface water degradation. Additional information would be needed on flow rates of receiving water at the time runoff entered it, and a measure of pollutants carried in the runoff [13]. However, data presented provide some indication of the reduction in the "maximum" pollution potential that would be realized through implementation of background and State guidelines.

Table 17--Number of fed-beef operations with runoff control problems, estimated runoff controlled under guidelines analyzed, and percent of runoff controlled, by capacity class, 1972

Capacity class (head), by region	Operations with runoff problems	Runoff controlled	Portion of total runoff	Cumulative portion of total runoff
	Number	Million gallons	Percent	Percent
Eastern States:				
<100	38,129	1,375	17	17
100-199	4,248	1,013	13	30
200-499	2,896	1,428	18	48
500-999	706	856	11	59
Western States:				
<1,000	2,244	360	5	64
Eastern States:				
1,000 or more	471	2,141	27	91
Western States:				
1,000 or more	139	706	9	100
Total	48,833	7,879	100	

If the 610 fed-beef operations with capacities of 1,000 head or more with runoff problems would install and use control systems, 36 percent of the runoff previously discharged by the industry would be controlled. The annual average total cost would be $0.60 per 1,000 gallons. It is often suggested that public agencies should equate the incremental benefits realized from runoff control to determine the "right amount of runoff." However, this is an irrelevant conceptual axiom when control agencies are required by legislative mandate to implement a "zero discharge" policy [3].

PROBLEMS OTHER THAN POINT SOURCE DISCHARGES

Point source runoff is not the only potential for environmental degradation associated with the fed-beef industry. Other environmental concerns are field runoff (that is, questions of the incorporation of manure solids and liquids into the soil at the time of application), odor problems at livestock production facilities and at the time of field application of wastes, and feedlot dusts. Such problems will vary in intensity with the production and waste handling technology in use and the capacity of operation. Operations found to be least affected by point source effluent limitations guidelines might be severely affected under subsequent environmental controls. Thus, decisionmaking under uncertainty will likely become more pronounced in the fed-beef industry as concern for environmental quality continues.

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APPENDIX A

Definitions [6]

Feedlot: The term feedlot shall mean a concentrated, confined animal or poultry operation for meat, milk, or egg production or stabling in pens or houses where the animals or poultry are fed at the place of confinement, and crop or forage production or growth is not sustained in the area of confinement.

Process Wastewater: The term process wastewater shall mean any process generated wastewater and any precipitation (rain or snow) which comes into contact with manure, litter, or bedding or any other raw material or intermediate or final material or product used in or resulting from the production of animal or poultry or direct products (e.g., milk, eggs).

Process Generated Wastewater: The term process generated wastewater shall mean any water directly or indirectly used in the operation of a feedlot for any or all of the following: Spillage or overflow from animal or poultry watering systems; washing, cleaning, or flushing pens, barns, manure pits, or other feedlot facilities; direct contact swimming, washing, or spray cooling of animals; and dust control.

Ten-year, 24-hour Rainfall: The term 10-year, 24-hour rainfall event shall mean a rainfall event with a probable recurrence interval of once in 10 years (for analysis, a 10-year, 24-hour rainfall event is a rainfall of a specific magnitude or greater that has a 1-in-10 chance of occurring in a 24-hour period in any given year).

Twenty-five year, 24-hour Rainfall: The term 25-year, 24-hour rainfall event shall mean a rainfall event with a probable recurrence interval of once in 25 years (for analysis, a 25-year, 24-hour rainfall event is a rainfall of a specific magnitude or greater that has a 1-in-25 chance of occurring in a 24-hour period in any given year).

APPENDIX B

Description of Housing Types

Total Confinement: Such systems consist of either cold-covered shelters enclosed on three sides with the fourth side fenced, or warm-enclosed shelters with all sides enclosed.

Dry-lot Paved: Such systems combine shelter and exposed areas, and the exposed areas are totally surfaced.

Dry-lot Unpaved: Such systems combine shelter and exposed areas, but the exposed areas are not surfaced except for feedlot aprons.

Open-lot: Such systems have no roofed shelters. The most prevalent open-lot system consists of fenceline bunk feeding with no surfacing except for that in front of feed bunks.